McMASTER

PREPARATION OF 1 KG OF IMMOBILIZED *R. ARRHIZUS* FOR BIOMASS ADSORPTION

FINAL REPORT

FOR

BIOTECHNOLOGY SECTION
ENERGY, MINES AND RESOURCES CANADA
OTTAWA, ONTARIO

BY

DR. MARIOS TSEZOS
DEPARTMENT OF CHEMICAL ENGINEERING
McMASTER UNIVERSITY
HAMILTON, ONTARIO

Work on this project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy Mines and Resources Canada.

Scientific Authority: Dr. R.G.L. McCready
Head, CANMET Biotechnology Section

SEPTEMBER 1990

Engineering

FACULTY OF ENGINEERING
McMaster University, Hamilton, Canada L8S 4L7

Telephone: (416) 525-9140 *Extension:* 4288 *Telex:* 061 8347

CONTRACT SERIAL NO. 09028-01-SS
CONTRACT REQUISITION NO. 23440-0-9028
CONTRACTOR: MCGILL UNIVERSITY

PREPARATION OF 1 KG OF IMMOBILIZED *R. ARRHIZUS* FOR BIOMASS ADSORPTION

FINAL REPORT

FOR

BIOTECHNOLOGY SECTION
ENERGY, MINES AND RESOURCES CANADA
OTTAWA, ONTARIO

BY

DR. MARIOS TSEZOS
DEPARTMENT OF CHEMICAL ENGINEERING
McMASTER UNIVERSITY
HAMILTON, ONTARIO

Work on this project was conducted under the auspices of the Canada Centre for Mineral and Energy Technology, Energy Mines and Resources Canada.

Scientific Authority: Dr. R.G.L. McCready
Head, CANMET Biotechnology Section

7 pp

SEPTEMBER 1990

MICROMEDIA

91-04694/

ABSTRACT

Immobilized *R. arrhizus* biomass was prepared using proprietary technology developed at McMaster University. The uranium adsorption characteristics of the biomass were determined.

RÉSUMÉ

Une biomasse de type *R. arrhizus* a été immobilisé selon une technique brevetée mise au point á l'Université McMaster. Les caractéristiques d'adsorption de l'uranium de cette biomasse ont été établies.

1. IMMOBILIZED BIOMASS PRODUCTION

1.1 INTRODUCTION

The purpose of this project was to prepare 1 kg of immobilized *R. arrhizus* biomass for uranium adsorption studies. The biomass was grown and immobilized using proprietary technology developed at McMaster University. Tests were also carried out to characterize the adsorptive properties of the biomass. This is the final report for contract DSS 23440-0-9028/01-SS.

1.2 BIOMASS GROWTH

The *R. arrhizus* biomass was produced by fermentation in a glucose medium. Sterile procedures were used to insure production of a pure strain of *R. arrhizus*. The fermentations were carried out in a bench top fermentor with duplicate 14 L glass fermentation vessels. The fermentor was equipped with pH and temperature controllers, mechanical agitators, and sterile air supply systems. The fermentations were carried out at a temperature of 28 °C with an air flow rate of approximately 7 L/min. The cultures showed first signs of growth after 24 hours with thick clumps of biomass observable after 36 hours. The biomass was harvested within 48 hours.

Upon completion of the fermentation, the contents of the fermentor vessels was filtered through nylon mesh filter bags to separate the *R. arrhizus* from the fermentation broth. The recovered biomass was then washed thoroughly with tap water until the wash water ran clear and colorless. Excess water was removed by squeezing the biomass in the filter bags. The biomass was broken up into smaller pieces, spread on metal trays, and covered with cheesecloth. The biomass was then autoclaved for 30 minutes at 120 °C and 105 kPa. The sterilized biomass was squeezed again to remove any condensed steam and broken into smaller particles. The biomass was then placed into metal sieves, covered with cheesecloth and lyophilized at -50 °C for two days in a freeze drier. The biomass was sieved to separate the 16-20 mesh size fraction for immobilization.

1.3 BIOMASS IMMOBILIZATION

The immobilization of the *R. arrhizus* biomass was carried out using the proprietary process developed at McMaster University, and 1 kg of immobilized biomass was produced.

2. BIOMASS PROPERTIES

2.1 URANIUM UPTAKE CAPACITY OF RAW BIOMASS

The uranium uptake capacity of the raw, uncoated biomass was tested by contacting samples of raw biomass with uranyl nitrate solution. Weighed biomass samples were placed into closed flasks with 100 mL of a 504 mg/L uranyl nitrate solution. The flasks were agitated on an orbital shaker for 24 hours. The solutions were then filtered to separate the biomass and the filtrate was analyzed for uranium concentration by ICP. The uranium uptake was calculated by mass balance. Table 1 gives the results of the uptake capacity tests for raw biomass. The raw biomass appears to exhibit uptake capacity similar to that observed in the past with similar biomass.

The Freundlich adsorption equation was fitted to the adsorption data for the raw biomass. The resulting adsorption curve is plotted in Figure 1. The following is the fitted adsorption equation:

$$q = 190.4C^{0.10}$$

where

q = uranium uptake, mg/g,

C = equilibrium liquid phase uranium concentration, mg/L.

2.2 URANIUM UPTAKE CAPACITY OF IMMOBILIZED BIOMASS

The uranium uptake capacity of the immobilized biomass was tested by contacting samples of immobilized biomass with uranyl nitrate solution. Weighed biomass samples were placed into closed flasks with 100 mL of a 502.3 mg/L uranyl nitrate solution. The flasks were agitated on an orbital shaker for 7 days. The solutions were then filtered to separate the biomass and the filtrate was analyzed for uranium concentration by ICP. The uranium uptake was calculated by mass balance. Table 2 gives the results of the uptake capacity tests. The immobilized biomass appears to exhibit uptake capacity similar to that observed in the past with similar biomass.

The Freundlich adsorption equation was fitted to the adsorption data for the immobilized biomass. The resulting adsorption curve is plotted in Figure 2. The following is the fitted adsorption equation:

$$q = 44.7C^{0.28}$$

TABLE 1: URANIUM UPTAKE CAPACITY OF RAW BIOMASS

FLASK NO.	U CONC. (mg/L)	U UPTAKE (mg/g)
1	339.4	329.2
2	171.5	332.5
3	59.0	296.7
4	15.2	244.4

TABLE 2: URANIUM UPTAKE CAPACITY OF IMMOBILIZED BIOMASS

FLASK NO.	U CONC. (mg/L)	U UPTAKE (mg/g)
1	428.4	241.5
2	357.7	285.8
3	347.4	212.5
4	291.4	231.8
5	263.1	205.1
6	208.9	188.6
7	145.2	178.2
8	85.1	165.0

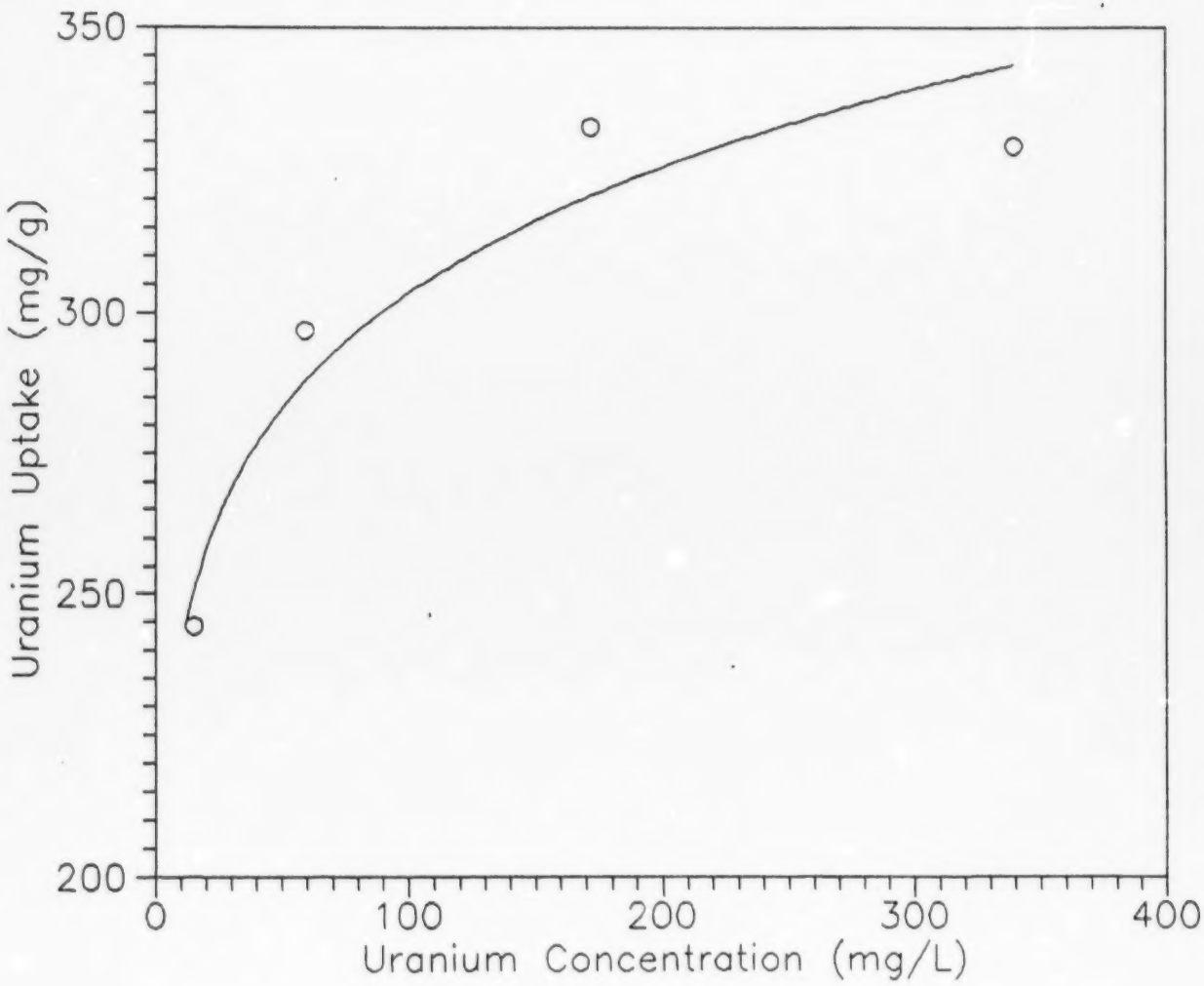

Figure 1 Uranium Uptake by Raw Biomass

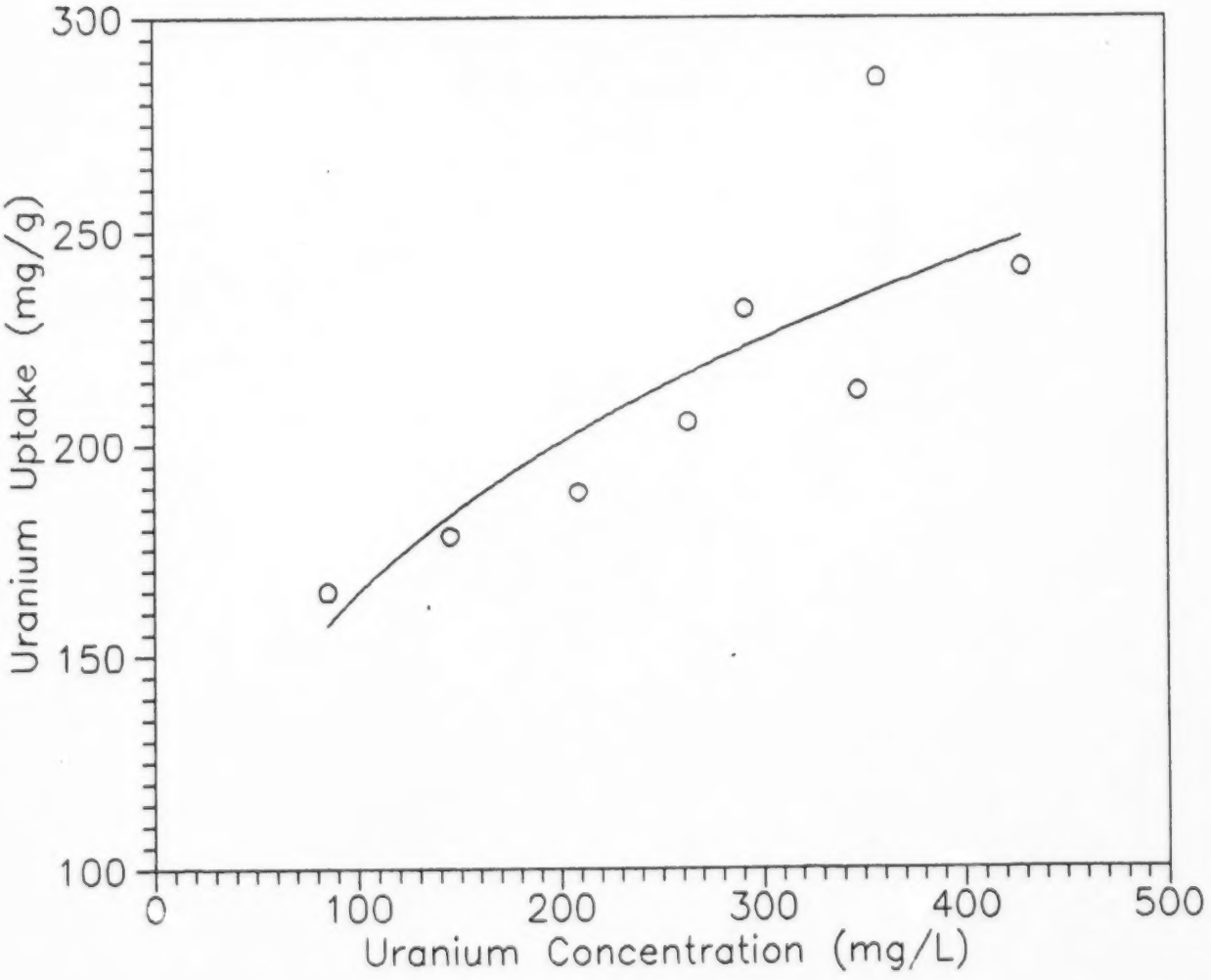

Figure 2 Uranium Uptake by Immobilized Biomass